APPENDIX NOT INCLUDED

Prepared for

United States Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas, Texas 75202

REMEDIAL ACTION REPORT FOR THE BAILEY SUPERFUND SITE ORANGE COUNTY, TEXAS VOLUME I

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GeoSyntec Project Number GE3913-630

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1. INTRODUCTION

1.1 Site Description and History

The Bailey Superfund Site is located approximately 3 miles southwest of Bridge City in Orange County, Texas. The site was originally part of a tidal marsh near the confluence of the Neches River and Sabine Lake. Two ponds, A and B, were constructed on the property by the landowner, Mr. Joe Bailey, as part of the Bailey Fish Camp in the early 1950s by dredging the marsh and piling the sediments to form levees which surround the ponds. The fish camp was active until September 1961 when it was destroyed by Hurricane Carla which introduced saline waters into the ponds, killing the freshwater fish. The total site, including the two rectangular ponds, occupies approximately 280 acres. However, the area of the site that required remediation comprises: (i) North Marsh Area (approximately 4 acres); (ii) North Dike Area (approximately 9 acres) and (iii) the East Dike Area (approximately 6 acres).

Mr. Bailey allowed the disposal of industrial and municipal waste within the levees along the north and east margins of Pond A during the 1950s and 1960s (the North Dike Area and the East Dike Area, respectively). In addition to the waste located within the North Dike Area (which includes waste contained in Pits A-1, A-3, and B) and East Dike Area, waste was also present in the North Marsh Area. The locations of these areas as well as other site features are shown in Figure 1.1. Waste disposal operations at the Bailey Waste Disposal site (subsequently referred to as the Bailey Superfund Site) ceased in 1971.

In 1984, the United States Environmental Protection Agency (USEPA) proposed the site for inclusion on the National Priorities List (NPL). The site was placed on the NPL in 1986. Originally, this site was a Texas Superfund Site and the Texas Natural Resource and Conservation Commission (TNRCC) was the lead agency. A remedial investigation (RI) was completed in October 1987 [Woodward-Clyde Consultants (WCC), 1987] under TNRCC's direction. After the RI, USEPA took over as the lead agency and a feasibility study (FS) was completed by Engineering Science, Inc. in April 1988 [Engineering Science, Inc., 1988] under USEPA's direction. USEPA selected an in-situ stabilization and capping remedy as a result and issued their Record of Decision (ROD) in June 1988. In 1989, members of the Bailey Task Force (later known as the Bailey Site Settlors Committee or BSSC) entered into a Consent Decree with USEPA. In addition, a mixed funding arrangement was agreed upon between the USEPA and the Bailey Task Force.

The remedial design was completed by Harding Lawson Associates (HLA) in November 1991 (HLA, 1991). Chemical Waste Management (CWM) was contracted as the remediation contractor, and mobilized to the site in September 1992 to implement the original remedy. Due to difficulties encountered during implementation of the original remedy, work at the site ceased in January 1994. Recognizing this fact, USEPA requested that BSSC further evaluate the feasibility of in-situ waste stabilization and to perform a Focused Feasibility Study (FFS) to identify whether more expedient and effective remedial actions for the site may be available.

In June 1995, the BSSC contracted Parsons Engineering Science (Parsons ES) to assume the contract administration/construction management services for the Bailey Site. GeoSyntec Consultants (GeoSyntec) was also contracted to provide engineering design services. FFS activities commenced in June 1995. The design for an interim remedial action, known as the Modified North Marsh Remediation, was developed concurrently. Through a competitive bid selection process, OHM Remediation Services (OHM) was contracted to conduct the interim remedial action. The interim remedial action took place between January and September 1996.

The FFS was completed in October 1996. Based on the results of the FFS, a revised remedy, consisting of consolidation of waste material into areas to be capped and construction of a lightweight composite cap, was selected and approved by USEPA. The design for this remedy was completed in December 1996. The BSSC contracted Parsons ES to continue providing Construction Management/Contract Administration services. GeoSyntec was also contracted to provide construction quality assurance (CQA) in the field during construction activities. Through a competitive bid selection process, OHM was contracted to conduct the revised remedial action. The revised remedial action was completed in August 1997. Figure 1.2 shows the key site features following completion of the revised remedial action.

1.2 Objectives of the Remedial Action

According to the Statement of Work appended to the 1990 Consent Decree, the objectives of the remedial action are the following:

- minimize the potential for waste migration;
- protect human health and the environment;
- prevent future contamination of surface water and groundwater; and
- minimize the potential short-term air emissions resulting from remedial activities.

1.3 Summary of Remedial Action

The remedial action was conducted in three phases: (i) implementation of some components of the Original Remedy, (ii) Interim Remedial Action (mainly remediation of the North Marsh Area and Pit B), and (iii) Final Revised Remedial Action. Each phase is described below.

1.3.1 Phase I: Implementation of Original Remedy

According to the ROD, the Original Remedy consisted of the following three components:

- consolidation of affected sediments from the marsh, drainage channel, drum disposal, and Pit A-3 sectors into the Waste Channel (North Dike Area) sector;
- in-situ stabilization of the waste in the Waste Channel sector and the sector East of Pond A (East Dike Area); and
- construction of a cover on top of the stabilized waste.

Remedial design and construction oversight was performed by HLA. The design of the Original Remedy is presented in the document entitled "Technical Specification" [HLA, 1992]. Difficulties were encountered during the remediation and implementation of the Original Remedy was not completed. The following components, however, were accomplished during implementation of the Original Remedy:

- waste/soil interface evaluation;
- consolidation and relocation of shallow wastes within the East Dike Area;
- construction of clay dikes around the East Dike Area;
- construction of access roads and support laydown area;
- stabilization of approximately one-third of the East Dike Area on the southern end;
- south drum disposal area remediation;
- closure of wells and piezometers;
- construction of a wastewater treatment plant; and
- air monitoring to ensure action levels on site were not exceeded.

Project Record Drawings of the Original Remedy are presented in Part 1 of Appendix A.

1.3.2 Phase II: Interim Remedial Action

An Interim Remedial Action was performed during the FFS. The design of the Interim Remedial Action was performed by GeoSyntec and is presented in the document entitled "Construction Specifications, Modified North Marsh Waste Remediation" [GeoSyntec, 1995]. The following activities were accomplished during the Interim Remedial Action:

- excavation of waste and affected sediments from the North Marsh Area and Pit B and transportation of this material to an off-site industrial landfill for solidification and disposal;
- excavation and on-site relocation of waste and affected sediments from Pits A-1 and A-3;
- verification that waste and affected sediments from the drainage channel and the south drum disposal area were removed during the Original Remedy;
- waste and affected sediment relocation from the drum disposal area located on the North Dike Area to the East Dike Area;
- placement of interim soil cover over south portion of the East Dike Area which had waste material exposed (active area);
- closure of an existing water supply well on site; and
- air monitoring during intrusive activities to ensure action levels on site were not exceeded.

Project Record Drawings of the Modified North Marsh Waste Remediation, Pit B Waste Removal, and East Dike Area Interim Closure are presented in Part 2 of Appendix A.

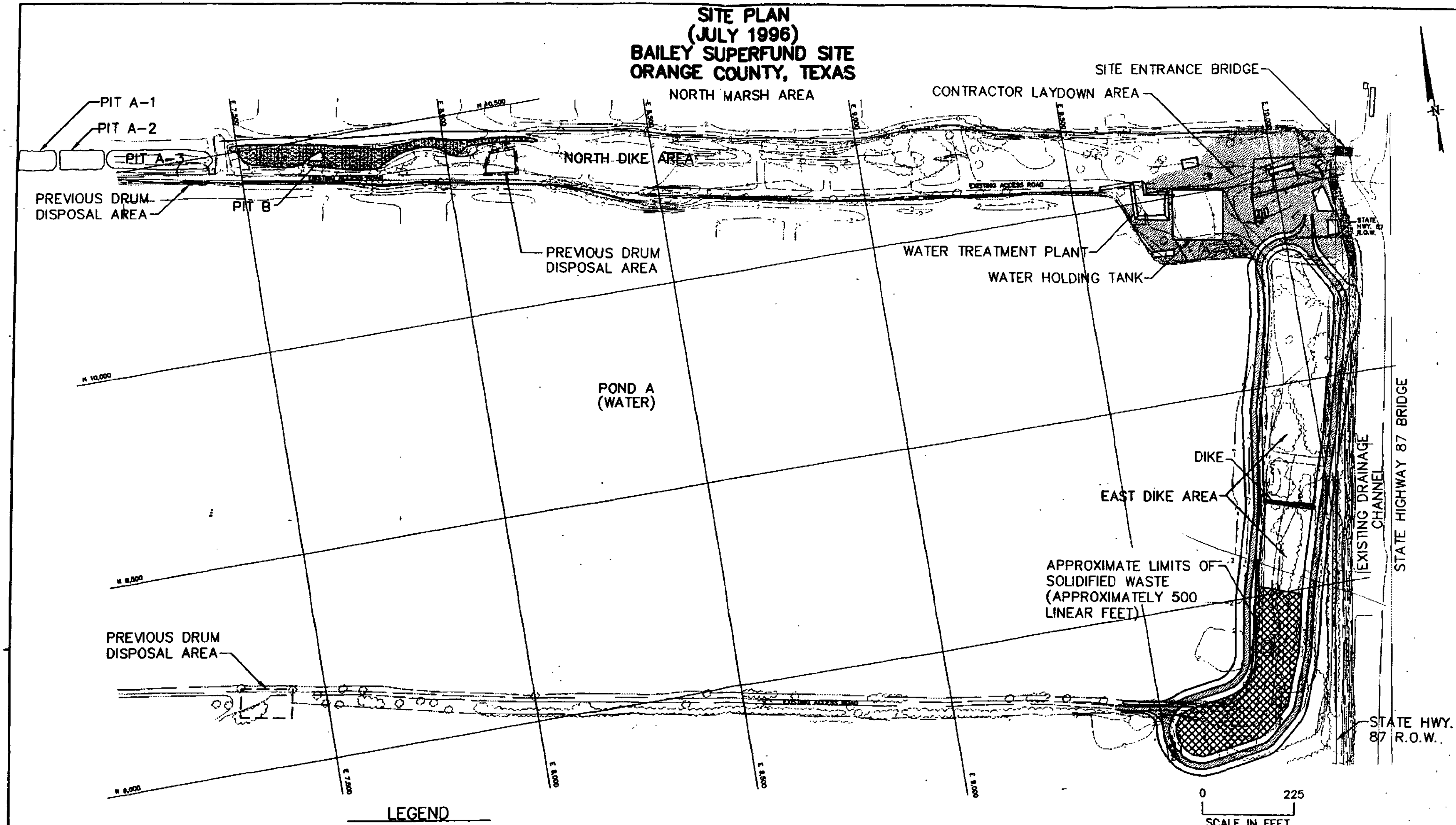
1.3.3 Phase III: Final Revised Remedial Action

The Final Revised Remedial Action was developed as a result of the FFS and is presented in the document entitled "Bid Form and Construction Specifications - Revised Remedial Design", [GeoSyntec, 1996]. The FFS is presented in a document entitled "Focused Feasibility Study Report, Revision 1", [GeoSyntec, 1996]. The ROD was amended in December 1996 consistent with the conclusions of the FFS. The amended ROD replaced the in-situ stabilization component of the Original Remedy with a lightweight cap over the site. Major activities performed during the Final Revised Remedial Action are summarized below:

- relocation and consolidation of surficial waste from the south edge of the North Dike Area to a location within the limits of the area to be capped;
- relocation and consolidation of bulk waste from the area adjacent to the former Pit B area to a location within the limits of the area to be capped;
- installation of a consolidation water collection system to intercept and remove groundwater that was elevated in the short term (i.e. during construction of the cap) due to consolidation of the waste (this water was taken off-site for disposal);
- construction of a lightweight composite cap over the East and North Dike Areas;
- construction of rip-rap slopes for erosion and scour protection along the edges of the capped areas;
- installation of storm water management controls to treat storm water runoff from disturbed areas during construction and to divert storm water runoff away from inactive or completed areas of the site;
- construction of maintenance roads;
- air monitoring during intrusive activities to ensure action levels on site were not exceeded; and

- installation of a passive gas venting system.

Photographs taken during the Interim Remedial Action and the Final Revised Remedial Action showing the various phases of construction work are presented in Appendix B. Project Record Drawings of the Final Revised Remedial Action are presented in Part 3 of Appendix A.



LEGEND

- APPROXIMATE LIMITS OF SOLIDIFIED WASTE
- APPROXIMATE LIMITS OF PIT B
- APPROXIMATE LIMITS OF GRAVEL SURFACING

NOTES:

1. BASE MAP PREPARED BY HARDING LAWSON ASSOCIATES, HOUSTON, TEXAS.
2. FIGURE FROM FOCUSED FEASIBILITY STUDY SEPTEMBER 1996.
3. SOLIDIFIED WASTE ON EAST DIKE AREA COMPLETED AS PART OF ORIGINAL REMEDY.

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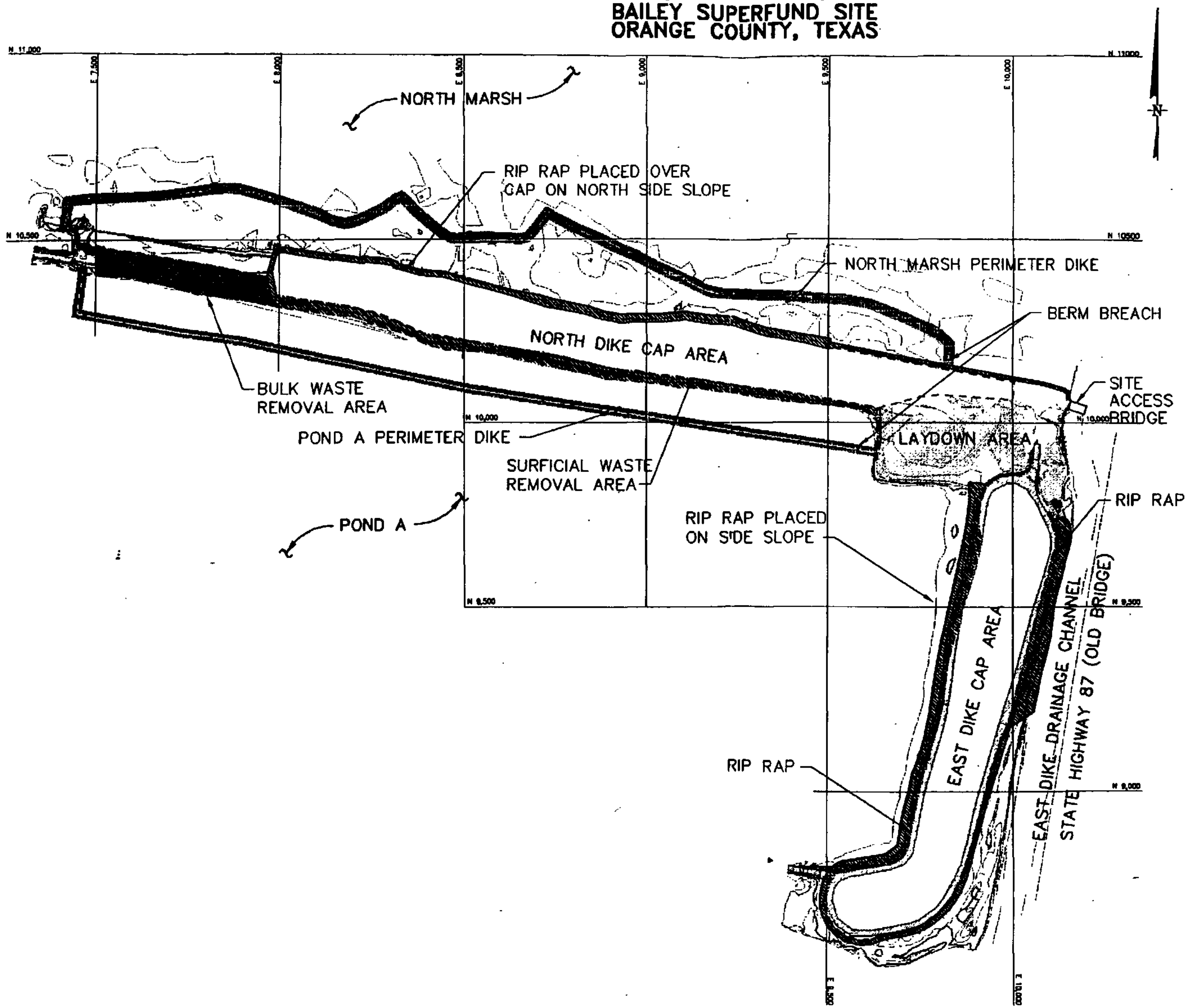
PROJECT NO.	GE3913-630	FIGURE NO.	1.1
DOCUMENT NO.	GA951411	FILE NO.	3913F004

SITE PLAN
(AUGUST 1997)
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS



NOTES:

1. DRAWING BASED ON PREVIOUS SITE TOPOGRAGHIC INFORMATION AND DESIGN DRAWINGS. DRAWING IS NOT BASED ON FINAL AS-BUILT DATA.
2. LOCATION OF EDGE OF WATER IS SUBJECT TO TIDAL VARIATIONS. AVERAGE TIDE ELEVATIONS ARE: LOW TIDE – −2.0 FEET (MSL) AND HIGH TIDE +1.0 FEET (MSL). TIDE ELEVATIONS ARE SUBJECT TO VARIATION DEPENDING ON SEASON AND LOCAL WEATHER CONDITIONS.
3. RIPRAP LOCATED ON ALL SLOPES.

LEGEND

EXISTING CONTOUR (FEET)

ANCHOR TRENCH

RIP RAP

0 300
SCALE IN FEET

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PROJECT NO. GE3913-630	FIGURE NO. 1.2
DOCUMENT NO.	FILE NO. 3913F005

2. CHRONOLOGY OF EVENTS

The following chronology of events related to the Bailey Superfund Site is presented below:

Event	Date
Site included on the National Priorities list (NPL)	1986
Remedial investigation completed by Woodward-Clyde	October 1987
Feasibility study completed by Engineering-Science	April 1988
Record of Decision (ROD) signed	June 28, 1988
Consent Decree (CD) signed	April 30, 1990
Remedial Design Completed by HLA	November 1991
Chemical Waste Management mobilizes to implement Original Remedy	September 1992
Work implementing the Original Remedy ceases	January 1994
North Marsh Design Completed by HLA	November 1994
McLaren Hart and Kiber Study[11]	February 1995
USEPA recommends a Focused Feasibility Study (FFS)	June 1995
Chemical Waste Management demobilizes from the site	June 1995
GeoSyntec begins FFS and associated studies; Parsons ES assumes Contract Administration/Construction Management (CA/CM) Services	June 1995
Modified North Marsh Design is Completed by GeoSyntec	November 1995
OHM mobilizes to conduct Interim Remedial Action	January 1996

[1] This study was conducted to assess the magnitude of difficulty to implement the Original Remedy.

Event	Date
Explanation of Significant Difference (ESD) Issued by USEPA for North Marsh	February 8, 1996
Explanation of Significant Difference (ESD) Issued by USEPA for Pit B	May 1, 1996
OHM completes Interim Remedial Action Activities	September 1996
Focused Feasibility Study Report Approved by USEPA	October 24, 1996
Record of Decision Amended	December 1996
Design of Final Revised Remedial Action completed by GeoSyntec	December 1996
OHM mobilizes to conduct final remediation	January 1997
Final Revised Remedial Action completed	August 1997
Amended Consent Decree Signed	To be determined

3. PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

3.1 Introduction

This section of the report describes the criteria and requirements for the remedial action contractor to achieve in completing the project. Specific performance standards and construction quality control procedures were not specified in the Consent Decree or its amendment. Rather, these standards and procedures were developed as part of the design effort. Performance standards and construction quality control procedures developed during the design are described for the phases of remediation summarized below:

- Phase I - Implementation of Original Remedy: Activities included waste consolidation, in-situ stabilization, and capping as described in the original ROD. The Original Remedy was not fully implemented due to the difficulties in meeting performance specifications.

- Phase II - Interim Remedial Action: Activities include remediation of the North Marsh Area and Pit B as described in Explanation of Significant Differences issued for each of these areas; and remediation of Pit A, the Drainage Channel, and the Drum Storage Areas as described in the original ROD for the site;

- Phase III - Final Revised Remedial Action: Activities include remediation of the East and North Dike Areas as described in the amended ROD, and issued on the basis of the revised remedial alternative recommended in the FFS. These activities included constructing a consolidation water collection trench (CWCT), excavating and consolidating surficial waste and bulk waste; and constructing a lightweight composite cap that included geosynthetic materials.

- Other performance standards include:

  - air monitoring to ensure compliance with site action levels; and
  - treatment of water in contact with waste.

3.2 Description of Performance Standards and Construction Quality Control

3.2.1 Phase I - Implementation of Original Remedy

The performance standards and construction quality control procedures developed during the design are described in the following paragraphs. Waste relocation and consolidation were completed during implementation of the Original Remedy. Waste stabilization was attempted; no capping activities commenced during implementation of the Original Remedy.

3.2.1.1 Waste Relocation/Consolidation

Waste and affected sediments from outside and underneath the East Dike footprint, the South Drum Disposal Area, and from the East Dike Drainage Channel were relocated and consolidated on the East Dike Area beneath the area to be capped. The performance standard used to evaluate the extent of remediation for both of these areas was visual removal of waste. During the Interim Remedial Action, the Construction Manager and the USEPA oversight contractor representative confirmed the waste and affected sediments had been excavated and removed to a visually clean standard. Photographs were taken to document the confirmation. Drawings of the waste relocation areas with Parsons ES's (construction manager) and USEPA's oversight contractor representative's signatures verifying inspection of each area are provided on Drawing 14 of 29 in Part 2 of Appendix A.

3.2.1.2 Perimeter Flood Protection Dike Around East Dike Area

The general performance standard for construction of the perimeter dike around the waste material in the East Dike Area was to confine the waste, reduce the likelihood of exposure of floodwaters to the waste material, restrict the lateral migration of the waste material, and provide a foundation for the final cover. The clay soils used to construct the perimeter dike were tested at a regular interval for the following index properties:

- Liquid Limit and Plastic Limit (ASTM D 4318);

- Minus #200 Sieve (ASTM D 422); and

- Moisture Density Relationship (ASTM D 698).

Laboratory test reports for the clay borrow material performed by HLA during the construction activities are presented in Part 1 of Appendix C. The borrow material placed for the perimeter flood control dike was required to be placed and compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D 698 (standard Proctor test). Field density tests were performed on the soils placed for the perimeter dike and are presented in Part 1 of Appendix C.

3.2.1.3 Waste Stabilization

During the original remedial design development, HLA developed performance criteria for solidification of the waste on the East and North Dike Areas. The performance standards for the solidified waste specified in "Technical Specifications" [HLA, 1992] were:

- a minimum unconfined compressive strength of 25 psi; and

- a hydraulic conductivity of no more than 1 x 10^{-6} cm/sec based on laboratory testing of cored solidified waste samples.

The selected remediation contractor, CWM, encountered difficulties in achieving the specified performance criteria (i.e., unconfined compressive strength and hydraulic conductivity). Stabilization was attempted in the southern third of the East Dike Area (known as the Active Area). The remedial action ceased due to difficulties in meeting the performance specifications. In light of the difficulties in meeting the project's stabilization specifications, USEPA requested the BSSC to conduct an FFS. Based on the FFS (conducted by GeoSyntec), GeoSyntec concluded that in-situ solidification of waste material to the specified performance criteria was impractical. The FFS also identified a more expedient and effective remedial action for the site. Based on the results of the FFS, a revised remedy was later approved by USEPA. Since the area that was stabilized was ultimately addressed by the final revised remedy, the original performance standards were no longer applicable.

3.2.1.4 Capping

The installation of the cap specified for the Original Remedy was never implemented due to difficulties with the waste stabilization component. However, the performance standard developed by HLA [HLA, 1992] for the compacted clay cap was to achieve a hydraulic conductivity no greater than 1×10^{-7} cm/sec.

3.2.2 Phase II - Interim Remedial Action

The performance standards and construction quality control procedures developed during the design and implementation of the Interim Remedial Action are described in the following paragraphs. A Construction Quality Assurance (CQA) Plan [GeoSyntec, 1996] was written for the implementation of the Interim Remedial Action. This plan was submitted and reviewed by the USEPA prior to the start of any site activities. The CQA Plan defined the scope, formal organization, and procedures necessary to ensure the project objectives were attained. The plan identified quality assurance and quality control monitoring and testing procedures, along with the frequency of tests to be performed by the CQA representative during the implementation of the Interim Remedial Action.

During the implementation of the Interim Remedial Action, the BSSC contracted GeoSyntec to provide full-time on-site CQA field services. A full-time Senior Engineering Technician was on-site during construction activities who performed quality assurance inspections and quality assurance documentation throughout the construction phase.

The remediation contractor for the Interim Remedial Action designated an individual to be the Quality Control (QC) Technician with the responsibility to verify compliance of work performed with the contract requirements. The QC technician reviewed construction submittals for compliance prior to submittal to the Construction Manager, and reviewed field activities for compliance with the construction drawings.

3.2.2.1 Remediation of the North Marsh Area and Pit B

For both the North Marsh Area and Pit B remediation, the performance standard was the removal of waste and affected sediments to a visually clean standard. This standard was originally specified in the "Technical Specifications for the North Marsh Waste Remediation" (HLA, 1994). Although these technical specifications were later modified for the actual implementation of the North Marsh Area Remediation in 1996 (referred to subsequently as the Modified North Marsh Remediation), the performance standard remained unchanged.

Waste and affected sediments were excavated until clean underlying soils were visible. Photographs were taken to document removal of the waste and affected sediments . Drawings of the North Marsh Area and Pit B excavation areas with Parsons ES's (construction manager) and USEPA's oversight contractor representative's signatures verifying inspection of each area are provided on Drawing 12 and 17 of 29 in Part 2 of Appendix A.

The waste and affected sediments from both the North Marsh Area and Pit B were found to be non-hazardous based on analytical testing of collected samples (documented in "Technical Memorandum - North Marsh Area Site Investigation and Evaluation of Original Remedy" [GeoSyntec, October 1996] and "Technical Memorandum - Pit B Pre-design Study" [GeoSyntec, June 1996]) and were taken off-site for disposal to the BFI Class I industrial waste disposal facility in Anahuac, Texas. Waste verification samples were collected from Pit B prior to excavation. Copies of the Pit B waste verification sample analyses are provided in Part 1 of Appendix D. The North Marsh waste was taken off-site for disposal to expedite this phase of remediation and to increase the long-term effectiveness of the final remedy. Also, off-site disposal of Pit B waste was ultimately found to be necessary, as demonstrated by the equivalency demonstration presented in the FFS. After removal of the Pit B waste, the effectiveness of implementing the revised remedial alternative developed in the FFS was determined to be technically equivalent to the Original Remedy in terms of source containment performance.

Off-site disposal of North Marsh and Pit B wastes was not in the original ROD (June 1988). The basis for classification of the waste and its disposal is documented in USEPA's Explanation of Significant Differences for the Record of Decision: Bailey

Waste Disposal Superfund Site (February 1996) for the North Marsh Area and USEPA's Explanation of Significant Differences for the Record of Decision: Bailey Waste Disposal Site - Pit B (May 1996).

3.2.2.2 Remediation of the Drainage Channel, the Drum Disposal Area, and Pit A

The performance standard was a visually clean standard for remediation of the Drum Disposal Area, the drainage channel which runs parallel to the East Dike Area on its eastern side, and Pits A-1 and A-3. The waste and affected sediments were relocated to the East Dike Area within the area to be capped. A representative from Parsons ES and USEPA's oversight contractor agreed that all waste and affected sediments had been removed to visually clean standard. Their signatures verifying this are shown in Drawing 14 of 29 in Part 2 of Appendix A.

Materials from the Drum Disposal Area south of the site, and the drainage channel were excavated and relocated within the area to be capped on the East Dike Area. This activity was performed by CWM during implementation of the Original Remedy. Verification that the work was performed to a visually clean standard was conducted later under the management of Parsons ES. To provide such verification, representatives from Parsons ES and USEPA's oversight contractor inspected the areas. In addition, OHM excavated a series of trenches along the east drainage channel to confirm that waste and affected sediments were not visually present. A representative from Parsons ES and USEPA's oversight contractor agreed that all waste and affected sediments had been removed from these areas to a visually clean standard. Their signatures verifying this as well as the location of the trenches made are shown in Drawing 14 of 29 in Part 2 of Appendix A.

Drums from a second drum disposal area approximately halfway down the North Dike Area (which lies beneath the capped area) were also disposed. The drum contents were disposed on the East Dike Area (within the capped area). The location of this disposal area is shown in Drawing 2 of 29 in Part 2 of Appendix A. The empty drums were crushed and disposed on the North Dike Area (within the capped area).

A third drum disposal area existed on the west end of the North Dike Area near Pit A-3 (shown in Drawing 1 of 5 in Part 1 of Appendix A). Drums in this area had deteriorated. Debris and waste from this area were excavated and relocated to the East Dike Area during remediation of Pit A-3.

3.2.2.3 Interim Capping of the East Dike Area

The Interim Remedial Action included the placement of a minimum of 12 in. of general fill soil over the southern half of the East Dike Area. This work was performed to eliminate the need for wastewater management within the East Dike until implementation of the Final Revised Remedial Action. Prior to placement of the soil cap, the existing subgrade was proof-rolled to detect soft areas. Soft areas were strengthened with the addition of a lime flyash until no pumping or rutting of waste by the dozer track was observed. This criteria was established to provide a material with an equivalent unconfined compressive strength of at least 5 psi. Waste material was then graded to permit the placement of a minimum of 12 inches of clean general fill. The general fill was placed and compacted to a minimum of 95 percent of the maximum dry density as determined by a standard proctor test (ASTM D-698). The perimeter dike was also graded to permit the drainage of surface runoff into Pond A or the drainage channel. Analytical tests performed on off-site borrow material is presented in Part 2 of Appendix D. Laboratory index tests and field density and moisture content tests performed on the interim cap material are provided in Part 2 of Appendix C.

3.2.3 Phase III - Final Revised Remedial Action

The performance standards and construction quality control procedures developed during the design and implementation of the revised remedial design are described in the following paragraphs. Major activities included: the construction of a consolidation water collection trench; waste relocation and consolidation; and the construction of a lightweight composite cap over both the North Dike Area and East Dike Area.

A Construction Quality Assurance (CQA) Plan (GeoSyntec, 1996) was written for the implementation of the revised remedial design. This plan was submitted and reviewed by the USEPA prior to the start of any site activities.

During the implementation of the Final Revised Remedial Action, the BSSC contracted GeoSyntec (CQA Engineer) to provide full-time on-site engineering and CQA field services. A full-time Resident Engineer (RE) was on-site during construction activities to address any design changes that were necessary to accommodate actual conditions encountered. The RE was assisted by senior field engineering technicians who performed quality assurance inspections and quality assurance documentation throughout the construction phase. The CQA Engineer also obtained conformance samples of construction materials to ensure compliance with the technical specifications.

The remediation contractor for the Final Revised Remedial Action designated an individual to be the Quality Control (QC) Technician with the responsibility to verify compliance of work performed with the contract requirements. The QC technician reviewed construction submittals for compliance prior to submittal to the Construction Manager, and reviewed field activities for compliance with the construction drawings.

3.2.3.1 Consolidation Water Collection Trench

The CWCT system was installed prior to any earthwork construction activities to collect ground water that may have been produced by consolidation of in-situ soils and waste due to the imposed load of the relocated waste and cap construction. The performance standards included setting the collection pipe invert elevation within the anticipated zone of influence. Collected water was conveyed to sumps by gravity feed and eventually taken off-site for disposal. Construction quality control was implemented by monitoring the elevation of the sumps and the lateral drain line slope during installation.

3.2.3.2 Waste Relocation/Consolidation

Surficial waste from the south side of the North Dike Area and bulk waste from the west end and east end of the North Dike Area were excavated and consolidated on the North Dike Area beneath the area to be capped. The performance standard used to evaluate the extent of remediation for both of these areas was removed to a visually clean standard. During the Final Remedial Action, the Construction Manager and the

USEPA oversight contractor representative confirmed that waste and affected sediments had been excavated to the performance standard. Photographs were taken to document the confirmation. Drawings of the waste relocation areas with verifying signatures are provided on Drawings 42 and 43 in Part 3 of Appendix A.

The general performance standard for the placement of relocated waste was the ability to support the lightweight geocomposite cover system. Compaction of the relocated waste was achieved by multiple passes of a dozer with standard tracks. No in-situ field density tests were performed on the compacted waste material due to the heterogeneous mixture of waste and soil. The degree of compaction was based on visual observation of the dozer operations. Some waste material required strength modification due to wet conditions. The performance standard for strength modification was to mix the soil/waste with a lime flyash until no pumping or rutting of waste by the dozer track was observed. This standard was established to provide a material with an equivalent unconfined compressive strength of at least 5 psi. Waste was placed in 12-inch maximum loose lifts and compacted by multiple passes of a dozer.

3.2.3.3 Capping

The revised remedial design required the installation of a lightweight composite cap that consisted of:

- a minimum of 12-inches of compacted clay soils over the waste material;
- layer of geosynthetic clay liner (GCL) material;
- high density polyethylene (HDPE) geomembrane;
- geocomposite drainage layer (GDL);
- a minimum of 12-inches of protective cover soils; and
- a six foot wide gas vent layer beneath the geomembrane liner with gas vents.

The performance standards for the composite cap included:

- cover all areas known to contain industrial wastes;
- placement and compaction of a minimum 12-inches of general fill soil over the waste to a minimum of 95 percent of the maximum dry density as determined by ASTM D-698 (standard proctor test);
- placement of a geocomposite gas vent layer along the ridge of the cap and gas vent pipes installed for every acre of cap;
- the GCL to have a hydraulic conductivity no greater than 10^{-7} cm/sec;
- the geomembrane to be made of high density polyethene with a minimum thickness of 60 mils; and
- the GDL to maintain a hydraulic transmissivity of at least 21 gal/min/ft.

Off-site borrow materials used for general fill and protective cover was tested for compliance with the project specifications. Material index property test reports for these soils are presented in Part 3 of Appendix C. Field density tests were performed by the CQA Engineer on the placement of the general fill material and are presented in Part 3 of Appendix C. A summary of the earthwork CQA testing for the Final Revised Remedial Action is presented in Table C-1 at the front of Part 3 in Appendix C.

Prior to installation of the geosynthetic components of the cap, the contractor was required to submit technical data for each component of the composite cap that indicated the material met the project specifications. The contractor was required to submit manufacturer's quality control data (MQC) on the delivered material at a general frequency of one set of data for each 40,000 square feet of material delivered to the site. Following acceptance of the MQC data, the CQA Engineer then obtained conformance samples of each material component and tested them for compliance with the project specifications at the frequency specified in the CQA Plan. Conformance sample data reports for each material are presented in Part 1 of Appendix E. A summary table of the test data for each material is presented in Tables E-1, E-2, and E-3 in Appendix E.

During the installation of the geosynthetic material components of the composite cap, the CQA Engineer performed full-time monitoring of installation activities for compliance with the project specifications. Some of the performance standards that were required include:

- subgrade preparation suitable for placement of geosynthetic material (written acceptance of the subgrade by the liner installer);
- adequate overlapping of geosynthetic clay liner material panels;
- proper welding of the geomembrane panels;
- no punctures, defects, or penetrations in the geomembrane liner;
- tying together and sewing of geocomposite drainage layer panel; and
- proper installation of gas vent layer, sumps, and pipes.

The CQA Engineer maintained daily field logs of geosynthetic material placements. Destructive samples of geomembrane welds were obtained and tested in the laboratory for peel and shear tests as required by the project specifications. The CQA Engineer obtained a total of 26 fusion weld and 2 extrusion weld destructive samples from the East Dike Area at an average frequency of one test for each 519 linear feet of fusion seam (see Part 2 of Appendix E). All samples tested met the project specifications. A total of 34 fusion and 1 extrusion destructive samples were obtained from the North Dike Area at an average frequency of one test for each 484 linear feet of fusion seam (see Part 2 of Appendix E). Only one seam sample on the North Dike Area failed to meet the project specification for peel and shear. This failure was attributed to a faulty heat roller on one of the seaming machines. Seams made that day by the identified piece of equipment were capped by placing an additional piece of GM and extrusion welding it in place. All extrusion welds were vacuum box tested for leaks and met specifications. Two additional destructive seam samples were obtained at the ends of the reported defective weld as required by the CQA Plan. Both conformational samples met the project specifications. The location of the destructive seam samples and the layout of the geomembrane panels is shown on the Geomembrane Panel Layout drawings for the East and North Dike Areas, Drawings No. 37 through 41 in Part 3 of Appendix A. Test reports of the destructive samples are presented in Part 2 of Appendix E.

The CQA Engineer also monitored the non-destructive seam testing of the geomembrane panels. A log of the non-destructive testing of the geomembrane seams was also maintained and is presented in Part 2 of Appendix E. The contractor also provided a full-time liner installation superintendent to supervise liner installation crews and perform construction quality control activities.

The review of MQC data and obtaining quality assurance conformance samples of the geosynthetic materials utilized in the construction of the lightweight composite cap, in addition to the full-time monitoring of installation by the CQA Engineer, documents that the performance standards for the composite cap construction were met.

3.2.4 Other Performance Standards

3.2.4.1 Control of Air Emissions

Site action levels for air emissions were established for the site based on worker health and safety protection levels. These action levels were established in the Air Monitoring Plan (HLA, 1991) and Revised Air Monitoring Plans (Parsons ES, 1995 and Parsons ES, 1996) and are summarized in Table C-1 in Part 3 of Appendix D. Confirmation samples were collected during the remediation to ensure that air emissions from the site were being controlled. Data collected during implementation of the Original Remedy were submitted in monthly reports to USEPA. Air data collected during the Interim Remedial Action and the Final Revised Remedial Action were also submitted in monthly reports to USEPA and are summarized in Table C-1 in Part 3 of Appendix D. No action levels were exceeded in confirmation air samples collected during the Interim Remedial Action and the Final Revised Remedial Action. The quality control procedures followed for collection of these samples are outlined in the Air Monitoring Plans cited above.

3.2.4.2 Treatment of Water and Wastewater in Contact with Waste

A summary of the wastewater data collected between August 1995 and January, 1997 is provided in Table C-2 in Part 4 of Appendix D. Table C-3 in Part 4 of Appendix D summarizes the results of quality control samples collected for wastewater. Full data sets from samples collected before and during this time period were submitted in monthly reports to USEPA during the project.

4. CONSTRUCTION/REMEDIATION ACTIVITIES

This section describes the remedial action undertaken at the site. Construction activities during implementation of the Original Remedy, Interim Remedial Action, and Final Revised Remedial Action are summarized. Photographs documenting the later two phases of remediation are provided in Appendix A.

4.1 Phase I - Implementation of Original Remedy

HLA was contracted by the BSSC to design and oversee the implementation of the Original Remedy as described in the ROD. CWM was contracted to implement the Original Remedy. The remediation work began in September 1992 and ceased in January 1994 due to difficulties encountered during stabilization of the East Dike Area. However, several components of the work were completed during this period and include the following:

- consolidation and relocation of shallow wastes in and around the East Dike Area;
- construction of perimeter flood protection dike around the East Dike Area ;
- south Drum Disposal Area remediation;
- construction of access roads;
- stabilization of approximately one third of the East Dike Area;
- closure of wells and piezometers; and
- construction of a wastewater treatment plant.

These activities are described in further detail below.

4.1.1 Waste/Soil Interface Investigation

CWM was required to evaluate the horizontal and vertical extent of the wastes during construction. This evaluation was done in accordance with the "Waste/Soil Interface Evaluation Plan" (HLA, October 1991). A survey grid was established at approximately 50-foot intervals and 114 borings were completed on the North and East Dike Areas. A hollow stem auger drill rig was used to evaluate the vertical extent of the waste. After native soils were observed, a Shelby tube was used to retrieve a sample for further verification and visual observation. A total of 208 shallow trenches (2-3 feet deep) were excavated on the North and East Dike Areas using conventional track mounted backhoes to evaluate the horizontal extent of the waste. The location of the waste was profiled from the clean interface to where the waste was 1 foot in depth. The locations were marked and surveyed. During the trenching on the North Dike Area, waste was discovered in the North Marsh. The horizontal and vertical extent of the waste in the marsh was evaluated using a hand auger from a boat.

The data from the Waste/Soil Interface Evaluation was compiled and Waste Stabilization Drawings were completed (Appendix F includes the data collected from the Waste/Soil Interface Evaluation and Drawings 3 and 5 of Part 1 of Appendix A delineate the waste/soil interface). As a result of the investigation, the estimated volume of the site waste increased from approximately 100,000 cubic yards to 156,000 cubic yards.

4.1.2 Consolidation and Relocation of Shallow Wastes Within the East Dike Area

Prior to the perimeter flood protection dike being constructed around the East Dike Area, shallow waste (i.e., areas where waste was generally less than 2 feet in depth) was excavated using conventional track mounted excavators and relocated inside the East Dike Area so as not to conflict with the footprint of the dike. Approximately 500 cubic yards of waste and affected sediments were excavated and relocated onto the East Dike Area within the limits of the capped area. The approximate limits of waste and the location of a clay key installed, which marks the boundary of the perimeter flood protection dike, is shown on Drawings 1 and 2 of 5 in Part 1 of Appendix A.

4.1.3 Construction of Perimeter Flood Protection Dike around East Dike Area and Construction of Access Roads

A perimeter flood control dike was constructed around the East Dike Area in accordance with the technical specifications [HLA, 1992]. The footprint of the dike is shown in Drawings 1 and 2 of 5 in Part 1 of Appendix A. Approximately 360,000 square feet of geogrid reinforcement was incorporated into the dike to provide support due to the extremely soft underlying soils. Approximately 12,000 tons of aggregate were placed under the dike in areas where the dike straddled Pond A and the drainage channel. The aggregate was imported to the site by dump trucks and placed using a bulldozer. A geotextile blanket (approximately 63,000 square feet) was installed over the aggregate prior to the clay fill placement. Approximately 81,000 cubic yards of clay fill was imported to the site for the East Dike construction. The dike was constructed in controlled lifts by placing the soil in 8-inch loose lifts. A pulvermixer was used to mix the clay and breakup large clods, bulldozers were used to spread the clay fill, and a self-propelled sheep's foot compactor was used to achieve compaction requirements. An access road was installed on top of the dike by spreading and compacting approximately 3,000 tons of aggregate.

Settlement was reported to be a problem during the dike construction due to existing soft soil conditions. The actual quantities of clay and aggregate fill required for the dike were approximately double the original estimated quantities due to the settlement encountered. For the most part, the settlement of the dike was uniform as documented by periodic settlement surveys. Survey data is provided in Appendix G. However, one section (approximately 300 feet) of the dike along the drainage channel exhibited excessive movement, and showed signs of a rotational failure (as evidenced by the presence of longitudinal tension cracks at the top of the slope). This section of the dike was re-constructed by reducing the width of the dike and using additional geogrids for reinforcement. Following reconstruction, this section of the dike was monitored and no further differential settlement was observed. During implementation of the Final Revised Remedial Action, no additional settlement or movement was observed for any section of the perimeter flood control dike around the East Dike Area. Since several feet of this dike was removed during the Final Revised Remedial Action, settlement in the future is not anticipated.

4.1.4 South Drum Disposal Area Remediation

Upon completion of the perimeter flood control dike around the East Dike Area, waste and affected sediments were excavated from the South Drum Disposal Area. A few corroded drums existed in the area, but the waste (saturated soil/black rubber crumb and carbon black) and affected sediments were excavated to an approximate depth of 1 to 2 feet. An estimated quantity of 2,123 cubic yards of material was excavated by using conventional track mounted backhoes. The material was loaded into dump trucks and hauled to the southern end of the East Dike Area and placed inside of the perimeter flood control dike. The excavated area was backfilled with imported clean fill to match the original topography.

4.1.5 Stabilization of Approximately One-Third of East Dike Area

Once all of the waste and affected sediments were consolidated into the diked areas of the East Dike Area, CWM began in-situ stabilization starting at the south end of the East Dike Area. CWM tried several different techniques to stabilize the waste which included the following:

1. Millgard (MEC-Tool) system (a vertical rotary auger mounted to a crane that would inject and mix a cement grout into the waste);
2. Conventional track mounted backhoe to mix dry cement dust in with the waste; and
3. Piranha system (a rotary blade attachment to the end of the backhoe arm that would inject and mix cement dust with the waste).

CWM attempted to stabilize approximately one-third of the East Dike Area (area is shown in Drawing 4 of 5 in Part 1 of Appendix A). CWM was not able to consistently meet the project specifications for stabilization. While the majority of the stabilized waste samples exceeded the minimum unconfined compressive strength requirement (25 pounds per square inch), a majority of the tested samples failed to meet the hydraulic conductivity specification (not greater than 1 x 10^{-6} centimeters per second) based on destructive testing of core samples. As a result of the difficulties encountered, remedial activities ceased in January 1994.

McLaren Hart and Kiber were retained to conduct a pilot-scale in-situ stabilization demonstration within the East Dike Area to assess the difficulty in achieving the project specifications. Based on the results presented in this study, as well as the results of various studies performed during the FFS, GeoSyntec concluded that in-situ stabilization of the waste material to the original project specifications would be technically infeasible based on the various compositions, heterogeneity, and organic content of the majority of waste. Implementing in-situ stabilization would be very difficult or impracticable to implement using cost effective and reliable construction techniques. Based on the findings of the FFS, the North Dike Area contains a larger percentage of municipal debris mixed with industrial waste, whereas waste on the East Dike Area mainly consists of industrial waste with very little municipal debris. Further information of waste characteristics on the North and East Dike Areas is documented in the North Dike Technical Memorandum [GeoSyntec, October, 1995] and the East Dike Technical Memorandum [GeoSyntec, December, 1995]. Recognizing these facts, the FFS evaluated whether more expedient and effective remedial actions for the site may be available.

4.1.6 Closure of Wells and Piezometers

During the Original Remedy, CWM was required to permanently abandon all environmental monitoring wells installed during the remedial investigation which were located within limits of the work. A total of 27 wells and piezometers were closed on the site. A Texas licensed driller was subcontracted to remove the well casings and overdrill the wells to full depth. The bore hole was then pumped full of a cement-bentonite slurry grout. The well casings were disposed on site.

4.1.7 Construction of Wastewater Treatment Plant

CWM also designed and installed a 500,000 gallon water holding tank and carbon adsorption water treatment system to treat potentially contaminated water generated during the construction operations, including decontamination water, stormwater from active areas, and groundwater from dewatering operations. This system was used in subsequent phases of work.

4.2 <u>Phase II - Interim Remedial Action</u>

Interim Remedial Action included remediation in the following areas: North Marsh Area; Pit A; and Pit B. OHM was contracted to conduct the North Marsh Area, Pit A, and Pit B remediation. Parsons ES was contracted for Construction Management/ Contract Administration services and GeoSyntec was contracted for design services.

4.2.1 Modified North Marsh Remediation

The Modified North Marsh Remediation began in February 1996 and was completed ahead of schedule in April 1996. This remediation was referred to as "modified" since technical specifications had been originally drafted and approved by USEPA in late 1994. The original design work was never implemented. Based on the results of additional sampling performed on the North Marsh Area waste, the technical specifications were revised and remedial action was referred to as the Modified North Marsh Remediation.

Dry weather conditions were a factor in completing the work ahead of schedule. The Modified North Marsh Remediation was comprised of the following major actions:

- construction of a temporary perimeter dike around the waste area in the North Marsh Area using marsh sediments;
- construction of intermediate dikes to isolate waste excavation areas and reduce contact of water with disturbed waste;
- construction of containment berm along the edge of Pond A to contain spills and prevent them from running off into Pond A;
- construction of a second wastewater treatment plant to handle treatment of water in contact with waste;
- construction of temporary access roads and decontamination facilities;
- excavation of approximately 7,908 cubic yards of North Marsh Area waste and affected sediments using longstick backhoes and transfer of waste to a material staging area; and
- transport of the waste and affected sediments to an industrial waste landfill (BFI, Anahuac facility), where it was conditioned to meet the landfill's handling requirements.

Table 4.1 summarizes the waste sent off-site for disposal during remediation at the Bailey Superfund Site. Waste manifests for waste disposed off-site are provided in Appendix H.

Management of wastewater was of critical importance during this phase of remediation, since a large area of waste had the potential to come into contact with surface water. The generation of wastewater was minimized during waste excavation by limiting the contact of surface water with waste. The use of three intermediate dikes helped to isolate waste areas being excavated from clean areas, so that only water in contact with disturbed waste required management. In addition, a material staging area was constructed to allow the waste to drain and dry prior to transport to the landfill. The dry construction season also helped in minimizing wastewater management during this phase.

One problem encountered during remediation of this area was the discovery of a waste face which became exposed during waste excavation on the northern bank of the North Dike Area. Plastic sheeting covered with 6 inches of clay was placed on this bank to provide temporary protection until it was permanently capped during the Final Revised Remedial Action.

4.2.2 Pit A-3 Remediation

Pit A-3 remediation commenced in May 1996 and was completed within two weeks. Prior to beginning remediation of Pit A-3, the quantity of waste in Pit A-3 was confirmed. The RI stated that approximately 35 cubic yards of waste were present in Pit A-3. However, after completion of preliminary trenches, a total of approximately 3,000 cubic yards of waste and affected sediments were found in Pit A-3 as well as Pit A-1. Waste and affected sediments from these areas were conditioned with approximately 7 percent (by weight) lime kiln dust using a backhoe, to facilitate handling. Pit A-3 waste and affected sediments were excavated, transported to the East Dike Area and consolidated in the area of the East Dike where stabilization had previously been attempted (i.e., the Active Area).

4.2.3 Pit B Remediation

Pit B remediation began in May 1996 and was completed in July 1996. Pit B remediation involved the following activities:

- excavation of clean soil platforms which extended into Pit B;
- dewatering of the Pit;
- mixing approximately 7 percent (by weight) lime kiln dust (LKD), section by section (using a total of nine sections), to the Pit B waste using a long-stick backhoe with air bucket (adapted to more effectively mix the LKD);
- sample collection and analysis for reactive sulfides and corrosivity from each of nine sections of the Pit (verification results collected during construction are provided in Part 1 of Appendix D);
- excavation of Pit B waste (tarry, mobile waste) and affected sediments from the area to achieve a visually clean standard, and transport of the waste and affected sediments to a material staging area;
- transportation of the waste and affected sediments to an industrial waste landfill (see Table 4.1);
- backfill with a minimum of one foot of clay; and
- breaching of the temporary perimeter dike in the North Marsh until final remediation activities commenced.

Several problems were incurred and overcome during remediation of Pit B. The original estimated quantity of waste and affected sediments in Pit B was 5,000 cubic yards based on the Pit B pre-design study (Technical Memorandum - Pit B Pre-Design Study, GeoSyntec, June 1996) results. The final quantity of waste and affected sediments in Pit B was estimated at 13,400 cubic yards. During excavation activities, the limits of tarry waste and underlying affected soils were found to extend deeper and further south underneath the roadway that paralleled the south edge of Pit B than was originally expected. A plastic sheet liner and clay cap were installed along the edge of the road along Pit B to temporary cover and contain exposed non-mobile waste until such waste could be removed during implementation of the Final Revised Remedial Action. Due to the nature of the Pit B waste as shown in the technical equivalency demonstration performed in the FFS and summarized in the ESD for Pit B (May 1996), the Pit B waste and underlying affected soils required removal prior to implementation of the Final Revised Remedial Action. Accordingly, the waste and underlying affected soils were removed from the site. Waste manifests for waste disposed off-site are provided in Appendix H.

A second problem which was incurred during Pit B remediation was wastewater management. Due to the depth of the waste excavation, significant quantities of water from the surrounding North Dike Area infiltrated into the excavation area, making conditions difficult to work in. To remedy this, a clay dam was built on the east side of Pit B to prevent water from the eastern portion of the dike from flowing into the excavation pit. Finally, difficulties were encountered in treatment of water from the Pit B area. This water had a significantly higher concentration of total organic carbon than previously encountered on site and the remediation contractor was unable to treat this water with the existing on-site plant equipment to the required discharge criteria. Parsons ES conducted a brief treatability study and cost analysis to evaluate the most cost effective course of action. Off-site disposal was evaluated to be the most cost-effective disposal option for the water. Arrangements were made to transport this water off-site to an industrial permitted facility. A total of 453,624 gallons of Pit B water were transported off-site (see Table 4.1). Manifests for disposal of the water are provided in Appendix H.

The drum disposal area located in the North Dike Area was remediated in April 1996. The contents (mostly soil cuttings and spent PPE) were disposed in the East Dike Area under the capped area. The drums were crushed and disposed in the North Dike Area. This area is located beneath the final cap. The South Drum Disposal Area was remediated during the Original Remedy.

Additional trenching was conducted along the East Dike Area to verify that there were no waste-affected sediments remaining in this location. The area was trenched and no waste-affected sediments were observed by representatives of Parsons ES or the USEPA's oversight contractor.

4.2.4 Interim Soil Cover Over the Active Portion of the East Dike Area

The Interim Remedial Action also included the placement of a soil cover over the active portion of the East Dike Area. This work was performed to eliminate the need for wastewater management within the East Dike Area until implementation of the Final Revised Remedial Action. The work included the following components:

- regrading of the existing area to conform to elevations and grades of the final design subgrade (for implementation of the Revised Remedial Design) and abandoning the stormwater piping ;

- installation of a temporary consolidation water collection trench and sump (approximately 215 lineal feet);

- placement of a minimum of 12 inches of compacted clean clay cover (4,344 loose cubic yards;

- grading of the active portion of the East Dike Area to conform to the elevations and grades of the interim soil cover;

- management of potentially contaminated wastewater from the working areas and the consolidation trench sump; and

- quartering of tires collected from the entire site and off-site disposal of these tires at an industrial waste landfill (see Table 4.1).

The interim soil cover over the active portion of the East Dike Area was completed in August 1996.

4.2.5 Closure of Remaining On-Site Well

One remaining 700-ft deep water well located in the material staging area, was closed during the Interim Remedial Action. Closure of this well took place in November 1996. A copy of the well abandonment form submitted to the TNRCC is provided in Appendix I.

4.3 Phase III - Final Revised Remedial Action

The revised remedial design consisted of constructing two separate lightweight composite caps, one each over the North and East Dike Areas. The major components of this remedial action included the following:

- construction of a perimeter dike;
- construction of consolidation water collection trenches;
- excavation and relocation of surficial waste;
- excavation and relocation of bulk waste;
- placement of subgrade soils;
- placement of rip rap on side slopes;
- construction of a lightweight composite cap, including protective cover material and a gas venting system;
- construction of a final maintenance road;
- revegetation of the cap area; and
- other site support activities.

Each element of the revised final remedial action is discussed in detail in the following sections. The Project Record Drawings of the revised remedial design, which include the construction drawings (Drawings 1 through 21) and as-built surveys (Drawings 22 through 43), are presented in Part 3 of Appendix A.

4.3.1 Perimeter Dikes

Prior to any waste excavation activities, a perimeter dike was constructed around the North Dike Area to allow excavation of waste material and construction work on the side slopes to be performed in dry conditions. Two breaches in the existing perimeter dike located on the north side of the North Dike Area (North Marsh Area) were backfilled at the start of construction activities. The location of the North Marsh perimeter dike and the two breach locations are shown on Drawing 2 in Part 3 of Appendix A. A second perimeter dike was constructed during the remedial action on the south side of the North Dike Area in Pond A. The as-built location of the Pond A perimeter dike is shown on Drawing 24 in Part 3 of Appendix A. Prior to constructing the Pond A perimeter dike, an intertidal silt fence was installed in Pond A outside the limits of the dike.

The design called for these dikes to be temporary and to be regraded back to natural grade at the completion of the work. However, during the implementation of the remedial action, it became apparent that the perimeter dikes provided an added buffer for the North Dike Area. The decision was made by the BSSC to leave the dikes in place since they provided a break to wave action on the side slopes of the capped area and reduced boat access to the capped area. A request to leave the perimeter dikes in place was presented to the USEPA, TNRCC, and to the National Oceanographic and Atmosphere Administration (NOAA). USEPA issued a letter acknowledging approval of this design change. At the completion of the rip rap placement on the side slopes, a breach was made in each dike to permit tidal waters to flow into the dewatered area.

4.3.2 Consolidation Water Collection Trench

A CWCT system was installed on both the East Dike Area and the North Dike Area. This system consisted of a series of gravel filled trench drains flowing into sumps. The location of the drain lines and the sumps for the East and North Dike Area are shown on Drawings 9, 10 and 11 in Part 3 of Appendix A. The CWCT system was installed prior to any earthwork construction activities to collect groundwater that may have been produced by consolidation of in-situ soils and waste due to the imposed load of the relocated waste and cap construction. The collection lines were located at a depth that was determined to be within the influence zone of the surcharge loading, yet located above the high tide level. The sumps were pumped twice daily using a trailer mounted vacuum pump system. The volume of liquid removed from each sump was monitored. The liquids removed from the sumps were placed in the water treatment plant holding tank and eventually disposed of off-site.

The pumping of the sumps was stopped 14 days after completion of the subgrade placement activities. The sumps were abandoned in place by removing at least two feet of the HDPE sump pipe below grade, then backfilling the sump area to eliminate potential voids under the cap in accordance with the construction specifications.

4.3.3 Surficial Waste Excavation and Consolidation

Field investigations indicated that waste material was present in a layer less than two feet thick along the south side slope of the North Dike Area. In order to reduce the area requiring capping, these surficial wastes were excavated and relocated to be within the limits of the cap. The surficial waste was removed at least five feet inside the cap perimeter anchor trench location. The surficial waste material was removed to visually clean standards. A total of 5,620 cubic yards of material was excavated and relocated. The as-built survey showing the extent of surficial waste removal is presented in Drawings 25 and 26 in Part 3 of Appendix A. As the excavation work proceeded, remediated areas were inspected by representatives of Parsons ES and USEPA for acceptance of the area. Documentation of this acceptance of the surficial waste excavation area is presented in Drawings 42 and 43 in Part 3 of Appendix A. Photographs of the remediated area were also taken to document the excavation effort.

Excavated surficial waste was placed on the North Dike Area within the limits of the cap. Waste material was spread in one foot lifts and compacted by multiple passes of a D-5 dozer with standard tracks. Soft or wet waste material was strengthened in place by the mixing of a lime-fly ash material with the waste. The criteria for acceptance of the waste strengthening was a visual determination of adequate support for the construction equipment. Large debris, such as concrete rubble, was placed at the far west end of the North Dike Area within the anchor trench limits.

The volume of surficial waste excavated started to exceed the original estimate early in the excavation process. This indicated that an adequate storage capacity for the waste material beneath the capped area may not be available based on the construction drawings. This required the Engineer to modify the subgrade elevations and cover slopes to accommodate a greater volume of waste. Revised construction drawings were made during the construction activities so that the contractor could proceed with the excavation activities without any delays (reference drawings 10-A and 11-A in Part 3 of Appendix A).

The areas where surficial waste was removed were backfilled with general fill to the subgrade design elevations. This material was placed in 6-inch compacted lifts.

The CQA Engineer monitored the placement of the backfill material and performed in-place field density tests (reference Section 3.2.3).

4.3.4 Bulk Waste Excavation and Consolidation

Waste material from underneath the access road along the southern edge of Pit B (as discussed previously in Section 4.2.3) that remained from the Interim Remedial Action was identified for removal and consolidation beneath the capped area. The limits of the bulk waste excavation work are shown on Drawing 8 in Part 3 of Appendix A. Due to limited access, the bulk waste excavation started at the western end of Pit B and proceed to the east. The bulk waste material was removed to visually clean standards. A total of 6,050 cubic yards of material was excavated and relocated. The as-built survey showing the extent of the bulk waste removal is presented in Drawings 27, 28, and 29 in Part 3 of Appendix A. As the excavation work proceeded, remediated areas were inspected by representatives of Parsons ES and USEPA for acceptance of the area. Documentation of this acceptance of the bulk waste excavation area is presented in Drawing 43 in Part 3 of Appendix A. Photographs of the remediated area were also taken to document the excavation effort.

The excavated bulk waste was placed and compacted on the North Dike Area in the same manner as the surficial waste discussed previously.

During the staking of the anchor trench on the North Dike Area, it became apparent that construction access across the site entrance bridge would be limited due to the eastern edge of the composite cover system. A contract change order was issued to excavate the waste material in this area and relocate it further west on the North Dike Area. The detail sketch showing the area of the cover system affected is shown on Drawing 36 in Part 3 of Appendix A. A total of 380 cubic yards of waste material was excavated and relocated. The as-built survey showing the extent of the bulk waste removed from the east end of the North Dike Area is presented in Drawing 30 in Part 3 of Appendix A. Once the excavation work was completed, the area was inspected by representatives of Parsons ES and USEPA for acceptance. Documentation of this acceptance of the limited bulk waste excavation area is presented in Drawing 42 in Part 3 of Appendix A. Photographs of the remediated area were also taken to document the excavation effort (Appendix B).

4.3.5 Subgrade Soil Cover

The design of the revised remedial action required the placement of a minimum of 12-inches of general fill between the waste material and the synthetic components of the lightweight composite cap. Grade stakes were used to set the elevation of waste fill to be 12-inches below the subgrade elevations. Once the waste material was placed, compacted, graded and proof-rolled, placement of off-site general fill borrow was performed. The subgrade soil cover was placed in 6-inch compacted lifts over all waste material until the design subgrade elevations were achieved. Field density tests on the general fill subgrade placement were performed (reference Section 3.2.3). Conformance samples of the general fill were also obtained and tested for compliance with the project specifications in accordance with the CQA plan (see Appendix C).

4.3.6 Rip Rap Slope Protection

Rip rap material was placed 12-in. thick on the side slopes of the East and North Dike Area to protect the slopes and the lightweight cover system from erosion and wave action. The rip rap consisted of steel slag with a gradation ranging from 2-in. to 8-in. diameter, and was supplied by International Mill Service Corporation (IMS), located in Beaumont, Texas. Prior to construction, a sample of the steel slag was submitted to a laboratory for TCLP testing for metals. Test results indicated that the slag material did not exceed the allowable TCLP values for metals. Test data on the rip rap material is presented in Part 3 of Appendix C.

On the north and west side slopes of the North Dike Area the rip rap was placed directly over the geosynthetic liner material with the 16-oz. non-woven fabric acting as a cushion layer (as required by the construction drawings). Rip rap was placed using a long-reach track mounted excavator that was able to place the rip rap with less than a 2-foot drop. One unique piece of equipment that was used successfully on this project as was an open-ended skid mounted box that permitted the rip rap haul trucks to back up into and dump their loads, then the long-reach excavator retrieved material out of the box. This kept the rip rap clean of soil, kept the rip rap out of the general fill layer underlying the synthetic liner, and provided a containment box for loading the rip rap into the excavator bucket. A total of approximately 12,950 tons of rip rap material was placed on the North and East Dike Area side slopes.

4.3.7 Lightweight Composite Cap

The lightweight composite cap protecting the waste material consisted of the following layers from the surface down:

- 12-inch minimum protective cover soil layer;
- one-sided geocomposite drainage layer (GDL);
- 60-mil HDPE geomembrane (GM);
- geosynthetic clay liner (GCL); and
- minimum 12-inches of clayey soil.

The specified properties and conformance sample test results for each of the geosynthetic materials is presented in Part 1 of Appendix E.

The synthetic liner material installation was subcontracted by OHM to Texas Environmental Plastics, Inc., Houston, Texas. The geomembrane panel layout drawing for the East Dike Area is presented in Drawing 37 and 38 in Part 3 of Appendix A. The geomembrane panel layout drawing for the North Dike Area is presented in Drawings 39, 40, and 41 in Part 3 of Appendix A. The 60-mil HDPE geomembrane was seamed using a dual track hot wedge fusion welder. This method permitted the non-destructive testing of the air channel created by the two seams. An extrusion welder was used for repairs and detail work. All areas requiring repairs or patches were marked and recorded on the panel layout drawings. The CQA Engineer monitored the non-destructive testing of the seams and obtained destructive samples of the fusion and extrusion seams as discussed previously in Section 3.2.3.3. A total of approximately 256,200 square feet of liner material was deployed on the East Dike Area and approximately 285,200 square feet of liner material was deployed on the North Dike Area.

The one-sided geocomposite drainage layer (GDL) was deployed over the geomembrane. Plastic ties were used to join the drainage net material along the edges and ends of the GDL rolls. The non-woven geotextile bonded to the drainage net material of adjoining panels was continuously sewn together. The CQA Engineer visually inspected the geotextile seams prior to placement of the protective cover material.

Protective cover material was placed over the GDL once the area was approved by the CQA Engineer. Due to limited site access, a temporary haul road was constructed on each dike consisting of 3 feet of protective cover soil over the liner material. Once material was delivered to the far ends of the dike, the material contained in the access road ramps were spread out using a low ground pressure (LGP) dozer. The LGP dozers spread, compacted, and graded the protective cover material to match the existing grade and maintain a minimum thickness of 12 inches. Thickness checks of the protective cover material were made on an approximate 50-foot grid.

4.3.8 Final Maintenance Road

Once the protective cover final grade was achieved, a final maintenance road was installed on the cap surface to facilitate the long-term inspection, maintenance and monitoring program. The design of the roadway cross-section was modified during the construction activities due to a shortage of available on-site gravel material. In place of using salvaged aggregate and ballast rock, the roadway design was modified to consist of a 6-inch thick layer of flexible base aggregate underlain by a layer of biaxial geogrid and geotextile material. The roadway alignment was also modified from the design to maintain it over more stable areas. The roadway alignment is shown on the As-built Topographic Survey (Final Grade) drawings for the East and North Dike Area, Drawings 34 and 35 respectively, in Part 3 of Appendix A.

4.3.9 Revegetation

Once the protective cover final grade was achieved, the vegetative cover was established by hydromulching. The vegetative cover consisted of a Bermuda grass as specified. To establish a quick vegetative cover to reduce erosion potential, the hydromulch mixture contained German mullet seed also.

4.3.10 Other Site Activities

Other construction activities that were performed as part of the revised remedial action included the following:

- Silt fences were installed around all areas that were subject to earthwork activities. Standard Texas Highway Department specified silt fence material was used on dry ground. A wire-mesh reinforced silt fence was used in areas subject to tidal flows, such as in Pond A and the North Marsh area.

- Abandonment of FFS piezometers and regrading of FFS settlement test pads.

- Off-site disposal of liquids remaining from the Pit B remediation activities (see Table 4.1). These liquids also included the water from the on-site well closure activities as discussed in Section 4.2.3 and the liquids collected from the CWCT sumps as discussed in Section 4.3.2. A total of approximately 450,200 gallons were transported off-site. Manifests for disposal of this water is presented in Appendix H.

- Cleaning out and regrading drainage ditches and culverts on-site to promote surface drainage. This included regrading of the site support zone to promote surface drainage.

- Installing a site security fence along the entire east and south side of the East Dike Area. This included the installation of gates on both ends of the site access bridge and at the southern end of the East Dike Area. Warning signs were also posted along the fenced areas in addition to posting warning signs on posts along the west side of the East Dike Area and the south and west sides of the North Dike Area.

- Removal and dismantling of the wastewater treatment plant and water storage tank.

- Demobilization of all remaining site support facilities, including utility lines, the truck scales, and job site trailers.

Table 4.1
Summary of Waste Sent Off-Site for Disposal[1]
Bailey Superfund Site
Orange County, Texas

Phase of Work	Description of Waste	Approximate Quantity of Waste	Disposal Facility	Date(s) of Disposal
Interim Remedial Action (North Marsh)	Tarry Waste and Soil, Class I, Non-Hazardous	7,908 C. Y.	BFI Facility Anahuac, TX	3/20/96 - 4/19/96
Interim Remedial Action (Pit B)	Tar-Like Waste and Underlying Soil, Class 1, Non-Hazardous	13,352 C.Y.	BFI Facility Anahuac, TX	5/21/96 - 7/19/96
Interim Remedial Action (Pit A and Pit B)	Quartered tires, Class I, Non-Hazardous	40 C. Y.	BFI Facility Anahuac, TX	8/14/96
Interim Remedial Action (Pit B)	Wastewater, Class I, Non-Hazardous	453,624 gallons	CECOS International West Lake, LA	9/3/96 - 9/10/96
Final Revised Remedial Action	Wastewater left over from Pit B, well closure activities, consolidation water from CWCT, and potentially contaminated surface water, Class I, Non-Hazardous	450,200 gallons	CECOS International West Lake, LA	2/11/97 - 5/4/97

[1] Table does not include construction debris which was not in contact with waste.

5. FINAL INSPECTION

This section discusses the pre-final and final inspections conducted at the site prior to completion of the Original Remedy, Interim Remedial Action, and Final Revised Remedial Action.

5.1 Phase I - Implementation of Original Remedy

The following components of the work were completed during the Original Remedy:

- waste/soil interface investigation;
- consolidation and relocation of shallow wastes within the East Dike Area;
- construction of perimeter flood protection dike around East Dike Area;
- construction of access roads and construction support laydown area;
- stabilization of approximately one third of the East Dike Area;
- South Drum Disposal Area remediation;
- closure of wells and piezometers; and
- construction of a wastewater treatment plant.

Due to the fact that work ceased due to difficulties with in-situ stabilization, no pre-final or final inspections of the Original Remedy work were performed. However, confirmation of the completion of these activities is presented in the as-built drawings for the Original Remedy work as presented in Part 1 of Appendix A and in the documentation of the conclusion of work for the Interim Remedial Action.

5.2 Phase II - Interim Remedial Action

The following components of the work were completed and accepted during the Interim Remedial Action Period:

- North Marsh waste remediation - April 17, 1996;
- Pit A waste remediation - May 17, 1996;
- East Dike trenching investigation along the drainage channel - June 7, 1996;
- South Drum Disposal Area remediation verification[1];
- Pit B waste remediation - July 13, 1996;
- temporary closure of East Dike Area - August 20, 1996; and
- closure of remaining on-site well - November 19, 1996.

Mr. Mark Murphy, Parsons ES's Site Manager, and Mr. Bill Schaeffer, USEPA's oversight contractor representative, were present for the final inspection of each area. Mr. Rafael De Castro and Mr. Barry Hayne, USEPA's oversight contractor representatives, participated in inspections of some work sections. Where waste excavation was involved, each working area was divided into sections and the sections were inspected as the work progressed. Drawings with initials documenting that the waste was removed are shown in Drawings 12, 14, and 17 of 29 in Part 2 of Appendix A.

At the completion of the Interim Remedial Action, a punch-list of the remaining items was developed and given to the contractor (see Appendix J). The contractor satisfactorily addressed and corrected these items.

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[1] Note: This work was completed during the Original Remedy activities, but was formally accepted and documented as being complete on June 7, 1996.

5.3 Phase III - Final Revised Remedial Action

The following components of the final remedial design were completed during the final revised remedial action site activities:

- installation of the Consolidation Water Collection Trench - February 19,1997;
- surficial waste excavation along the south side slope of the North Dike Area - March 11, 1997;
- bulk waste excavation from the south side of Pit B, west of the North Dike Area - April 01, 1997;
- completion of subgrade placement on the East Dike Area - April 18, 1997;
- completion of subgrade placement on the North Dike Area - June 03, 1997;
- completion of deployment of geosynthetic cap materials for the East Dike Area - May 16, 1997;
- completion of deployment of geosynthetic cap materials for the North Dike Area - June 26, 1997;
- placement of protective cover material on the North Dike Area - July 19, 1997;
- placement of protective cover material on the East Dike Area - July 26, 1997; and
- construction substantial completion notification - July 29, 1997.

A pre-final site inspection was conducted on July 31, 1997. This inspection was attended by the following personnel:

- Chris Villareal - USEPA (Remedial Project Manager);
- Trey Collins - TNRCC (Superfund Engineering Section);
- Pat Steerman - BSSC Technical Committee Chairman;
- Lou Levi - BSSC Technical Committee member;
- Jackie Travers - Parsons ES (Project Engineer);
- Mark Murphy - Parsons ES (Site Manager);
- Jim Brewer - GeoSyntec Consultants (Resident Design Engineer); and
- Gary Foster - OHM Remediation Services (Construction Project Manager).

At the completion of the pre-final site inspection, a punch list of the remaining items was developed and given to the contractor (see Appendix J). The contractor satisfactorily addressed and corrected these items, with the exception of the removal of the silt fences which will be left in place pending the establishment of vegetative growth on the cap surface.

On August 20, 1997, a final site inspection was conducted. This site walk was attended by the following personnel:

- Chris Villareal - USEPA (Remedial Project Manager);
- Pat Steerman - BSSC Technical Committee Chairman;
- Lou Levi - BSSC Technical Committee member;
- Mark Murphy - Parsons ES (Site Manager);
- Jim Brewer - GeoSyntec Consultants (Resident Design Engineer); and
- Sid Richard - OHM Remediation Services (Construction Supervisor).

All items on the pre-final site inspection punch list were satisfactorily addressed and no further actions were required, with the exception of the maintenance of the vegetative growth and removal of the silt fences which will be left in place pending the establishment of vegetative growth on the cap surface.

6. CERTIFICATE OF COMPLETION

6.1 Original Remedy

The waste delineation for the site was performed in accordance with the Waste/Soil Interface Evaluation Plan (HLA, October 1991) and all data collected during the delineation is provided in Appendix F.

Waste and affected sediments from the South Drum Disposal Area and the East Dike Area were excavated and consolidated within the limits of the East Dike Area in accordance with the Original Remedy construction drawings and specifications (HLA, 1992). Project record drawings are provided in Part 1 of Appendix A.

The perimeter flood protection dike around the East Dike Area was constructed in accordance with the approved Original Remedy drawings and specifications (HLA, 1992). As-built drawings are located in Part 1 of Appendix A.

The southern portion of the East Dike Area was stabilized as shown in Drawing 4 of 5 in Part 1 of Appendix A. It was demonstrated during the Interim Remedial Action (by proof-rolling) that this area is capable of providing sufficient support for the construction of a light-weight geosynthetic cap.

6.2 Interim Remedial Action

Waste and affected sediments from the North Marsh, Pit A-1, Pit A-3, Pit B, the South Drum Disposal Area, and the drainage channel were excavated from these areas. The performance standard was visual removal of waste. This determination was made by representatives from Parsons ES and USEPA's oversight contractor, acting on behalf of the USEPA. Signatures of the representatives affirming that such standards were met are found in Drawings 12A, 14, and 17 of 29 in Part 2 of Appendix A. Waste and affected sediments from the North Marsh and Pit B were taken off-site to an industrial waste landfill (see Table 4.1). Waste and affected sediments from the remaining areas were transported to the East Dike Area and were buried beneath the area to be capped.

Project record drawings for the Interim Remedial Action are provided in Part 2 of Appendix A.

6.3 Final Revised Remedial Action

The excavation and relocation of surficial waste and bulk waste located on the North Dike Area and the subsequent construction of a lightweight composite cap was performed in accordance with the approved Revised Remedial Design construction drawings and specifications (GeoSyntec, 1997). The performance standard for the waste excavation was visual removal of the waste. This determination was made by representatives of Parsons ES and USEPA's oversight contractor, acting on behalf of the USEPA. Signatures of the representatives affirming that such standards were met are found in Drawings 42 and 43 in Part 3 of Appendix A. All waste and affected sediments were transported to the North or East Dike Area and buried beneath the limits of the capped area. No hazardous solid waste materials were disposed of off-site. Affected stormwater and water from the consolidation water collection trenches were taken off-site to an industrial waste disposal facility. Project record drawings, which include the as-built construction drawings and as-built surveys for the Final Revised Remedial Action, are provided in Part 3 of Appendix A.

The BSSC has met the requirement for adequacy of performance of activities and reports as required under the terms of the Consent Decree. The completion of the construction activities have met the following objectives of the Consent Decree:

- minimize the potential for waste migration;
- protect human health and the environment;
- prevent future contamination of surface water and groundwater; and
- minimize the potential short-term air emissions resulting from remedial activities.

7. OPERATION AND MAINTENANCE PLAN

Long-term maintenance of the site is addressed in the Final Inspection, Maintenance, and Monitoring (IMM) Plan [Parsons ES and GeoSyntec, September 1997]. This plan was approved by USEPA on September 15, 1997. The plan outlines inspection and maintenance procedures and frequencies to be implemented throughout the IMM period. These procedures include grounds, fence, sign, access bridge, and road inspection and maintenance. Mowing frequencies and areas to be maintained are specified.

8. PROJECT COSTS

This remedial action was funded by the Bailey Site Settlors Committee (BSSC). Engineering and construction costs incurred during the remediation of the Bailey Superfund Site are provided in Table 8.1. These costs do not include EPA oversight and transaction costs (i.e., legal and administrative costs). A more detailed breakdown of projects costs are provided in Appendix K.

Table 8.1
Summary of Engineering and Construction Costs
Bailey Superfund Site
Orange County, Texas

Work Component	Engineering and Construction Cost
ORIGINAL REMEDY	10,827,128
INTERIM REMEDIAL ACTION	6,086,018
FINAL REVISED REMEDIAL ACTION[1]	4,447,000
TOTAL	**$21,360,146**

(1) These costs are estimated since final costs have not been issued at the date of this report.

Note: These costs do not include EPA oversight or transaction costs.

APPENDIX A

PROJECT RECORD DRAWINGS